
Space Weather Technical Forecast

Issued on Tuesday, 06 December 2022 at 01:11 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Chance of G1 midweek UTC. Marginal Active electron fluence Likely to start and end period.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with occasional small C-class X-ray flares observed by GOES16, on a relatively flat background that straddled C and B-class. These peaked with a C2.7 at 05/0530UTC from AR3158 in the central northern hemisphere. This group showed growth in its intermediate and leading portions in the 24 hours to become a Dri/Beta by the period's end. This was one of up to seven sunspot regions on the visible disc, with the disc dominated areally and in terms of nominal complexity by AR3153 in the southeastern quadrant, although this group was quiet despite some growth in its intermediate spots and its Fhi/Beta classification. The remaining sunspots on the disc were otherwise stable dipoles, perhaps joined into the UTC evening by a small unnumbered unipolar region in the northeast, and perhaps also by returning Ex-3150 in the far northeast, which presented as an Hrx/Alpha.

Starting around 05/1530UTC, a disturbance was noted across the southern end of a northeastern quadrant filament near 20E. At least some of these feature appears to remain in place in subsequent H-alpha imagery, and it may be that it has failed to leave the immediate solar environment. A second nearby event occurred at 05/2130UTC, with a smaller filament to the immediate northwest of the first also appearing to lift off. For now there was no evidence of any Earth-bound Coronal Mass Ejections (CMEs) in available satellite imagery, but the aforementioned events are borne in mind.

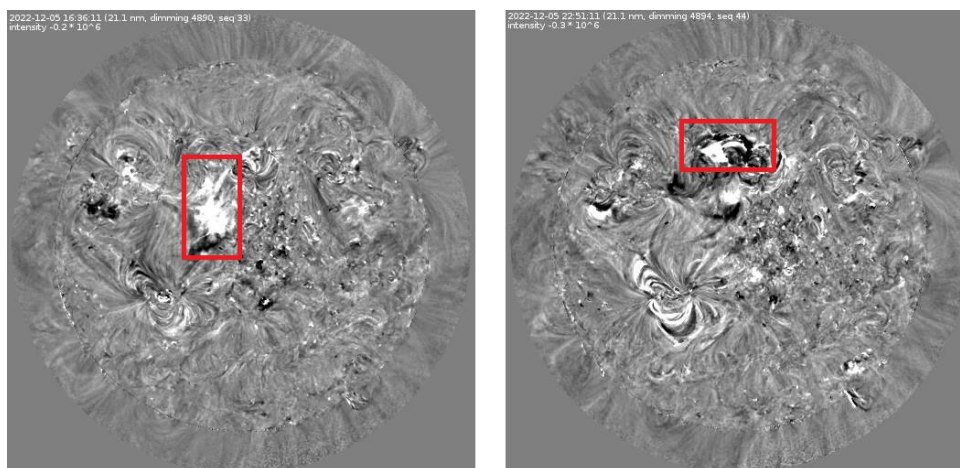


Figure 0: Time integrated AIA 211 imagery sequences of two potential filament lift-offs in the period – respectively one peaking around 05/1530UTC and a second 05/2130UTC. Image processing courtesy of SIDC ROB.

Perhaps also of note has been a semi-persistent very large prominence in the southwest, although for the time being this remains anchored in place.

Solar Wind / Geomagnetic Activity: Solar winds, as observed at L1 by DSCOVR, were suggestive of a gradual exit from a recent fast wind. The suggested feature is CH51/+, and the phi angle was accordingly positive (away from the Sun) throughout.

The solar wind speed showed a gradual decline from Elevated to Slightly Elevated levels in the period, declining from near 525km/s to level off near 450 into the final hours of the 24. The solar wind density showed a similar decline, from near 10ppcc to single figures as the period evolved. The IMF was relatively constant near 5nT at peak, with a north-south range of +5 and -4nT. Much of the 24-hour period was spent in anti-aligned territory with respect to Earth's field, although this lessened as the period drew to a close.

The net result of the above solar wind measures was provisionally Quiet throughout, with Kp at or below '2o' for all eight 3-hour intervals.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES16 has remained at Background levels.

High energy electron flux (greater than 2MeV) at GOES16 ranged between Moderate and High in the period, peaking at 2610pfu at 05/1450UTC. The associated 24-hour Fluence was above the Active (1e8 integrated pfu) threshold for a time, but with the declining trend eventually seeing this fall narrowly below from 05/1800UTC. Observed fluence at 06/0001UTC was 9.63e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: There is a daily Chance of isolated M-class flares, perhaps most likely from AR3158 and AR3153, although the appearance of the current sunspots is not reflective of their observed flare activity. No significant regions arrive or depart in the four days.

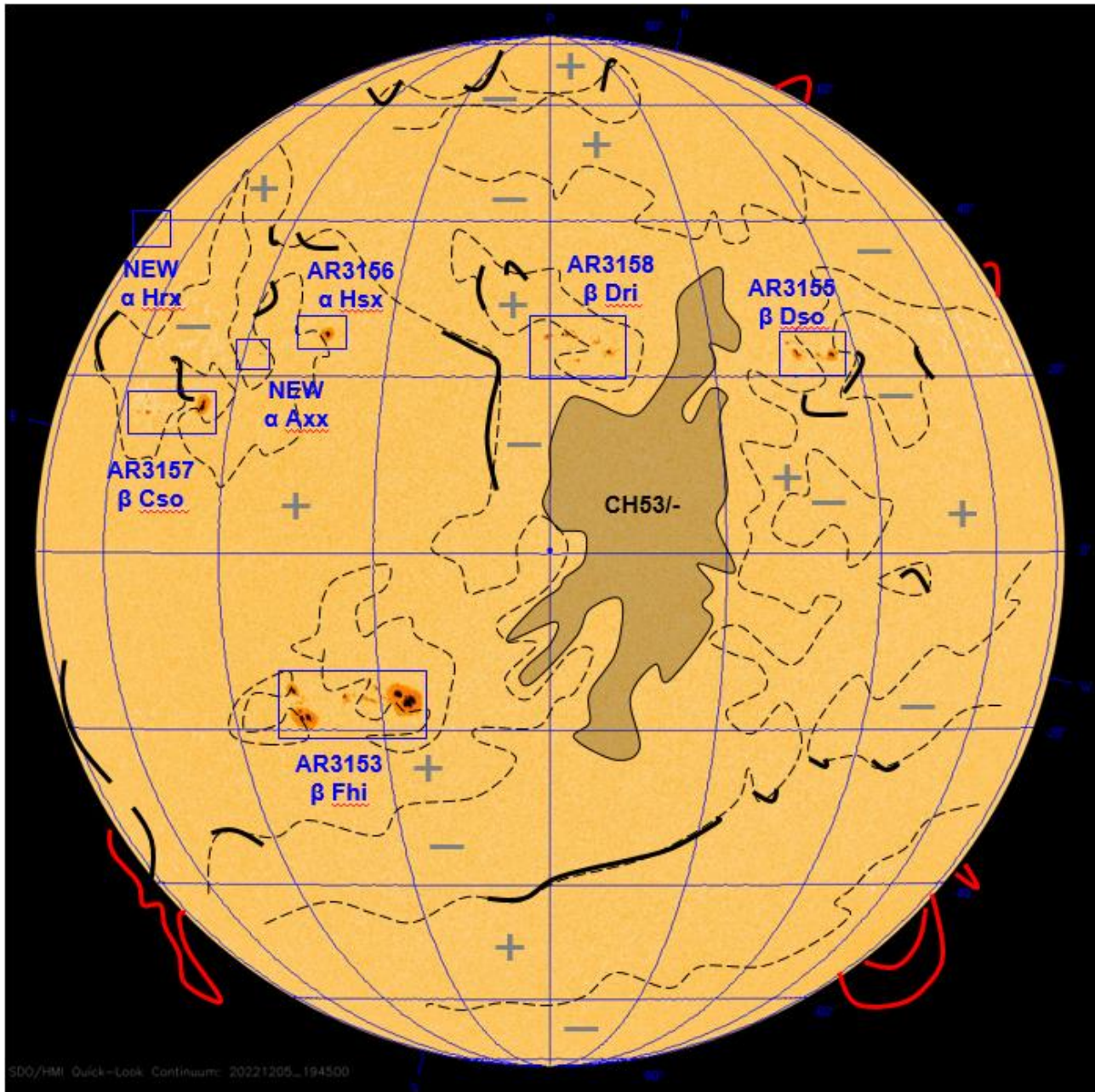
Solar Wind / Geomagnetic Activity: No CMEs feature in the current forecast.

The incumbent fast wind from CH51/+ has now long-since peaked, and a resumption of Quiet geomagnetic activity is expected until the advent of following CH53/- on Wednesday 07 December. This is larger and more intense than last pass, and carries a Chance of Minor Storm G1 despite our proximity to the solstice. Activity should then wane once again to Quiet by the end of the current UTC working week.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) at GEO is expected to remain at Background throughout.

High energy electron flux (greater than 2 MeV), is expected to continue its current Moderate to High flux diurnal oscillation in the near-term, with 24-hour integrated fluence perhaps narrowly realised as a result. Levels should apparently fall later on Wednesday 07 December in response to geomagnetic activity related to CH53/-, before a probable rebound before the UTC weekend.

Figure 1. Solar Analysis Valid 05/1945UTC.



Key: Filament ____, Prominence ____, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-γ-δ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

No CMEs feature in the current forecast.

The recent fast wind from CH51 has now peaked and is decidedly in decline, with a slow regime and Quiet geomagnetic activity expected to shortly resume.

Attention then turns to the large negative polarity succeeding feature in the form of CH53/- which dominates the disc in AIA211 and 193 imagery. This feature is much-changed relative to last rotation, appearing visually larger and more intense, and uncertainty as to its effect is relatively high. In terms of other checks and balances, its polarity makes little difference to its potency at this stage of the year. In addition, there is the fact that Earth crosses the solar equatorial plane southwards around the time this feature becomes geoeffective, which is by one school of thought the absolute semi-annual minimum risk for any coronal hole (else being the solstice itself).

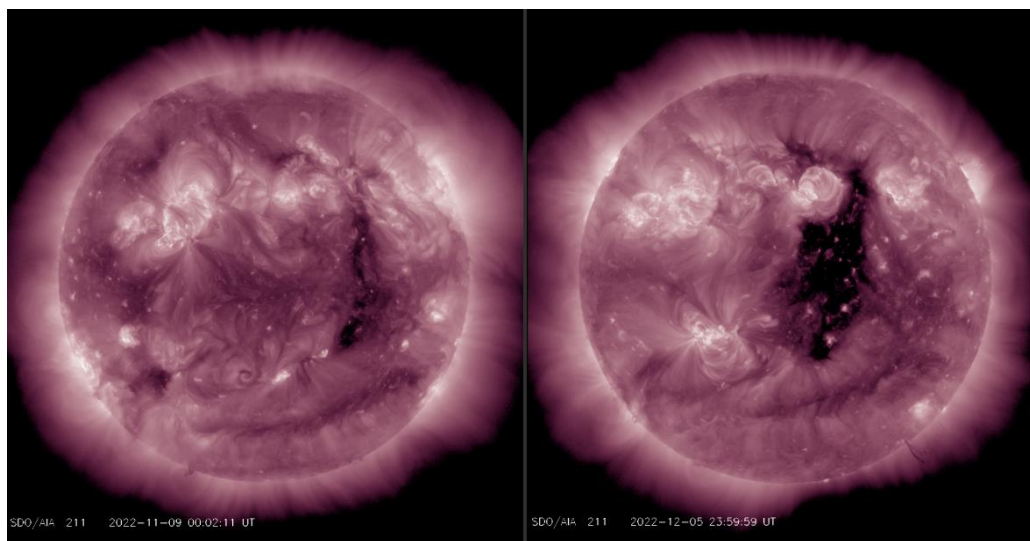
The effects of CH53 are yet to be seen at STEREO A, which puts geoeffectivity very likely outside the first 24-hour period, hence the nominal risk of G1. MOSWOC Enlil suggests peak winds of 500km/s arriving on Thursday 08 December, but given the recently posited risk of 600km/s, possible onset late on 07 December is still favoured, with a peak Chance of G1. This risk is partitioned between the two days with a bias to the former, probably fading to Quiet once again as we round out the coming UTC working week.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	1	30	20	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

Figure 2: AIA 211 imagery from the previous and current rotations, showing a large difference in the geometry of upcoming coronal hole 53



Radio Blackouts - X-Ray Flares:

Solar activity carries a daily Chance of increasing to Moderate given the nominal complexity of the current disc, although this has so far failed to manifest in significant flare activity.

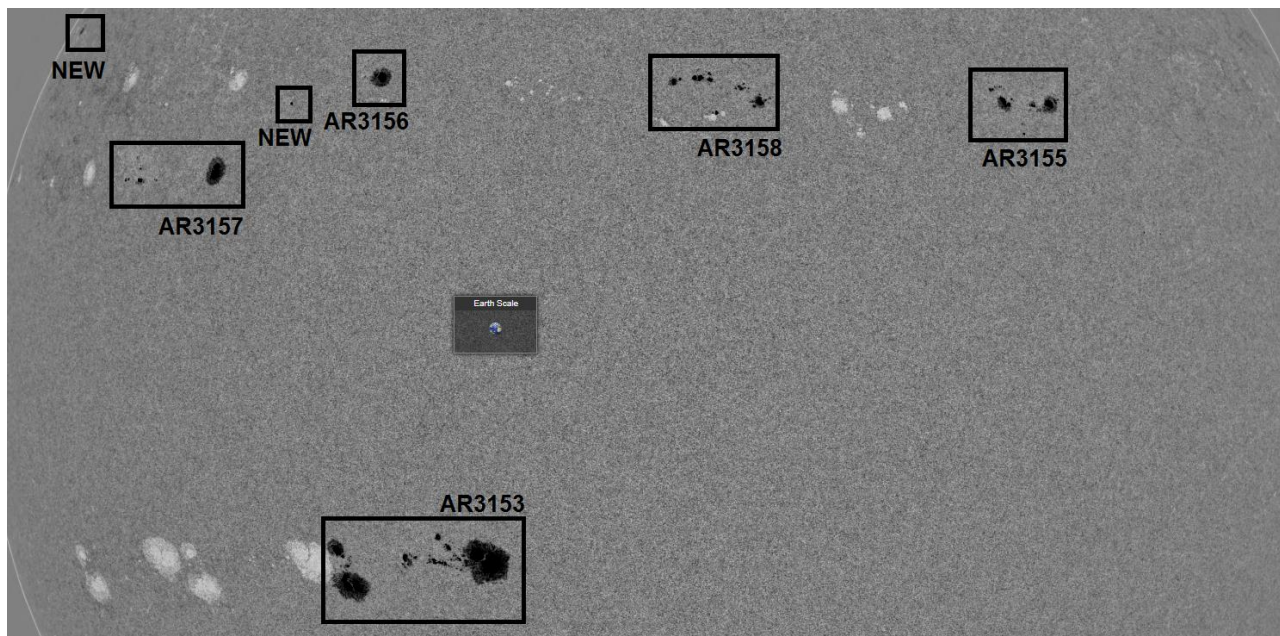
The largest and nominally most complex region on the disc remains AR3153 in the southeastern quadrant, which currently appears as an Fhi/Beta group, with a 17-degree span on the solar disc. This spot region showed some proliferation in its intermediate portion in the period, however this was not matched by any notable flares. Although much smaller, also of note in terms of dynamism in the period was AR3158 in the north centre-disc, which developed numerous small leading and intermediate spots, but again with no notable associated flares. The other sunspot regions were relatively stable, simple dipoles over the past 24 hours.

The daily chances of M-class flare activity have been revised down from suggested raw values for the current disc: from Likely to a Chance, given the observed quiet X-ray trace in low C-class. In terms of the balance of groups over the four days, none of the current crop leave the Earth-facing side. Meanwhile, Ex-3150 may have recently appeared on the northeastern limb as an apparent Hrx/Alpha. with further rotation perhaps likely to reveal further minor detail here.

All considered, all the sunspots likely to be present in the period are now on the facing side, and a flat daily Chance of M-class flares is suggested throughout.

X Flares	Ray	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability				(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	No	40	40	40	40
Very Active	R3 to R5 X Class	No	No	1	1	1	1

Figure 3: Helioviewer.org-derived HMIF imagery sequence, showing the footprints of current sunspots 05/2330UTC (black) and those 30 and 60 hours ago. Note especially the growth of AR3158 and the proliferation of intermediate spots in AR3153.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) carries a daily Slight Chance of seeing S1 or greater levels at GEO due to the gradual westward advance of the current cohort of sunspots - although this rise is too slight to show in the percentage risks. This has been revised downwards slightly from suggested raw values given the observed lack of even modest flares.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	5	5	5	5
Very Active	$\geq \text{S3}$ *	No	1	1	1	1

* S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)

High Energy Electrons Event ($\geq 2\text{MeV}$):

High energy electron flux (greater than 2 MeV), is currently demonstrating a diurnal oscillation between Moderate and High flux. This is giving recent very marginal Active electron fluence, and this is expected to continue until the onset of geomagnetic activity from CH53, probably on or just after midweek UTC. This will apparently dent counts for a time, but they are considered Likely to rebound before the end of the UTC week.

Confidence in the above forecast is relatively low, as despite the absence of transients in the forecast, the driving coronal hole is much-changed from its previous incarnation, and the flux and fluence levels enter the period in a finely-balanced and marginal state.

All considered, Active electron fluence is Likely to start and end the four days, with a probable intervening drop.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	Yes	80	60	20	60
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1